

# CHARMED, STRANGE MESONS

$(C = S = \pm 1)$

$D_s^+ = c\bar{s}$ ,  $D_s^- = \bar{c}s$ , similarly for  $D_s^*$ 's

$D_s^\pm$

$I(J^P) = 0(0^-)$

Mass  $m = 1968.50 \pm 0.32$  MeV ( $S = 1.3$ )  
 $m_{D_s^\pm} - m_{D^\pm} = 98.87 \pm 0.29$  MeV ( $S = 1.4$ )  
Mean life  $\tau = (500 \pm 7) \times 10^{-15}$  s ( $S = 1.3$ )  
 $c\tau = 149.9 \mu\text{m}$

### **$CP$ -violating decay-rate asymmetries**

$A_{CP}(\mu^\pm\nu) = (5 \pm 6)\%$   
 $A_{CP}(K^\pm K_S^0) = (0.3 \pm 0.4)\%$   
 $A_{CP}(K^+ K^- \pi^\pm) = (0.3 \pm 1.4)\%$   
 $A_{CP}(K^+ K^- \pi^\pm \pi^0) = (-6 \pm 4)\%$   
 $A_{CP}(K_S^0 K^\mp 2\pi^\pm) = (-1 \pm 4)\%$   
 $A_{CP}(\pi^+ \pi^- \pi^\pm) = (2 \pm 5)\%$   
 $A_{CP}(\pi^\pm \eta) = (-4.6 \pm 2.9)\%$   
 $A_{CP}(\pi^\pm \eta') = (-6.1 \pm 3.0)\%$   
 $A_{CP}(K^\pm \pi^0) = (-27 \pm 24)\%$   
 $A_{CP}(K_S^0 \pi^\pm) = (6.6 \pm 3.3)\%$  ( $S = 1.4$ )  
 $A_{CP}(K^\pm \pi^+ \pi^-) = (11 \pm 7)\%$   
 $A_{CP}(K^\pm \eta) = (9 \pm 15)\%$   
 $A_{CP}(K^\pm \eta'(958)) = (6 \pm 19)\%$

### **$T$ -violating decay-rate asymmetry**

$A_T(K_S^0 K^\pm \pi^+ \pi^-) = (-14 \pm 8) \times 10^{-3}$  [a]

### **$D_s^+ \rightarrow \phi \ell^+ \nu_\ell$ form factors**

$r_2 = 0.84 \pm 0.11$  ( $S = 2.4$ )  
 $r_\nu = 1.80 \pm 0.08$   
 $\Gamma_L/\Gamma_T = 0.72 \pm 0.18$

NODE=MXXX040

NODE=S034

NODE=S034M;DTYPE=M

NODE=S034DM;DTYPE=D

NODE=S034T;DTYPE=T

NODE=S034CTA;DTYPE=C;OUR EVAL

CLUMP=P

NODE=S034A13;DTYPE=v;CLUMP=P

NODE=S034A05;DTYPE=v;CLUMP=P

NODE=S034A06;DTYPE=v;CLUMP=P

NODE=S034A07;DTYPE=v;CLUMP=P

NODE=S034A08;DTYPE=v;CLUMP=P

NODE=S034A09;DTYPE=v;CLUMP=P

NODE=S034A10;DTYPE=v;CLUMP=P

NODE=S034A11;DTYPE=v;CLUMP=P

NODE=S034A12;DTYPE=v;CLUMP=P

NODE=S034A03;DTYPE=v;CLUMP=P

NODE=S034A04;DTYPE=v;CLUMP=P

CLUMP=T

NODE=S034TV0;DTYPE=t;CLUMP=T

CLUMP=F

NODE=S034FR2;DTYPE=f;CLUMP=F

NODE=S034FRV;DTYPE=f;CLUMP=F

NODE=S034GLT;DTYPE=f;CLUMP=F

Unless otherwise noted, the branching fractions for modes with a resonance in the final state include all the decay modes of the resonance.  $D_s^-$  modes are charge conjugates of the modes below.

NODE=S034215;NODE=S034

| $D_s^+$ DECAY MODES  | Fraction ( $\Gamma_i/\Gamma$ )       | Scale factor/<br>Confidence level    | $p$<br>(MeV/c)                        |
|--|--------------------------------------|--------------------------------------|---------------------------------------|
| <b>Inclusive modes</b>                                       |                                      |                                      |                                       |
| $e^+$ semileptonic   | [b] ( 6.5 ± 0.4 ) %                  | —                                    | NODE=S034;CLUMP=D<br>DESIG=25         |
| $\pi^+$ anything   | ( 119.3 ± 1.4 ) %                    | —                                    | DESIG=133                             |
| $\pi^-$ anything   | ( 43.2 ± 0.9 ) %                     | —                                    | DESIG=134                             |
| $\pi^0$ anything   | ( 123 ± 7 ) %                        | —                                    | DESIG=135                             |
| $K^-$ anything   | ( 18.7 ± 0.5 ) %                     | —                                    | DESIG=32                              |
| $K^+$ anything   | ( 28.9 ± 0.7 ) %                     | —                                    | DESIG=33                              |
| $K_S^0$ anything   | ( 19.0 ± 1.1 ) %                     | —                                    | DESIG=138                             |
| $\eta$ anything  | [c] ( 29.9 ± 2.8 ) %                 | —                                    | DESIG=2                               |
| $\omega$ anything  | ( 6.1 ± 1.4 ) %                      | —                                    | DESIG=136                             |
| $\eta'$ anything   | [d] ( 11.7 ± 1.8 ) %                 | —                                    | DESIG=117                             |
| $f_0(980)$ anything, $f_0 \rightarrow \pi^+ \pi^-$           | < 1.3 %                              | CL=90%                               | —                                     |
| $\phi$ anything  | ( 15.7 ± 1.0 ) %                     | —                                    | DESIG=92                              |
| $K^+ K^-$ anything   | ( 15.8 ± 0.7 ) %                     | —                                    | DESIG=139                             |
| $K_S^0 K^+$ anything   | ( 5.8 ± 0.5 ) %                      | —                                    | DESIG=140                             |
| $K_S^0 K^-$ anything   | ( 1.9 ± 0.4 ) %                      | —                                    | DESIG=141                             |
| $2K_S^0$ anything  | ( 1.70 ± 0.32 ) %                    | —                                    | DESIG=142                             |
| $2K^+$ anything  | < 2.6 × 10 <sup>-3</sup>             | CL=90%                               | —                                     |
| $2K^-$ anything  | < 6 × 10 <sup>-4</sup>               | CL=90%                               | —                                     |
| <b>Leptonic and semileptonic modes</b>                       |                                      |                                      |                                       |
| $e^+ \nu_e$  | < 1.2 × 10 <sup>-4</sup>             | CL=90%                               | 984<br>NODE=S034;CLUMP=C<br>DESIG=118 |
| $\mu^+ \nu_\mu$  | ( 5.90 ± 0.33 ) × 10 <sup>-3</sup>   | —                                    | 981<br>DESIG=7                        |
| $\tau^+ \nu_\tau$  | ( 5.43 ± 0.31 ) %                    | —                                    | 182<br>DESIG=89                       |
| $K^+ K^- e^+ \nu_e$  | —                                    | —                                    | 851<br>DESIG=125;OUR EVAL             |
| $\phi e^+ \nu_e$   | [e] ( 2.49 ± 0.14 ) %                | 720<br>DESIG=30                      |                                       |
| $\eta e^+ \nu_e + \eta'(958) e^+ \nu_e$                      | [e] ( 3.66 ± 0.37 ) %                | —                                    | DESIG=85;OUR EVAL                     |
| $\eta e^+ \nu_e$   | [e] ( 2.67 ± 0.29 ) %                | S=1.1<br>908<br>DESIG=86             |                                       |
| $\eta'(958) e^+ \nu_e$                                       | [e] ( 9.9 ± 2.3 ) × 10 <sup>-3</sup> | 751<br>DESIG=87                      |                                       |
| $\omega e^+ \nu_e$   | [f] < 2.0 × 10 <sup>-3</sup>         | CL=90%                               | 829<br>DESIG=153                      |
| $K^0 e^+ \nu_e$  | ( 3.7 ± 1.0 ) × 10 <sup>-3</sup>     | —                                    | 921<br>DESIG=145                      |
| $K^*(892)^0 e^+ \nu_e$                                       | [e] ( 1.8 ± 0.7 ) × 10 <sup>-3</sup> | 782<br>DESIG=146                     |                                       |
| $f_0(980) e^+ \nu_e, f_0 \rightarrow \pi^+ \pi^-$            | ( 2.00 ± 0.32 ) × 10 <sup>-3</sup>   | —                                    | DESIG=147                             |
| <b>Hadronic modes with a <math>K\bar{K}</math> pair</b>      |                                      |                                      |                                       |
| $K^+ K_S^0$  | ( 1.48 ± 0.08 ) %                    | 850<br>NODE=S034;CLUMP=A<br>DESIG=22 |                                       |
| $K^+ K^- \pi^+$  | [g] ( 5.49 ± 0.27 ) %                | 805<br>DESIG=40                      |                                       |
| $\phi \pi^+$   | [e,h] ( 4.5 ± 0.4 ) %                | 712<br>DESIG=6                       |                                       |
| $\phi \pi^+, \phi \rightarrow K^+ K^-$                       | [h] ( 2.28 ± 0.12 ) %                | 712<br>DESIG=114                     |                                       |
| $K^+ \bar{K}^*(892)^0, \bar{K}^{*0} \rightarrow K^- \pi^+$   | ( 2.63 ± 0.13 ) %                    | 416<br>DESIG=115                     |                                       |
| $f_0(980) \pi^+, f_0 \rightarrow K^+ K^-$                    | ( 1.16 ± 0.32 ) %                    | 732<br>DESIG=79                      |                                       |
| $f_0(1370) \pi^+, f_0 \rightarrow K^+ K^-$                   | ( 7 ± 5 ) × 10 <sup>-4</sup>         | —                                    | DESIG=148                             |
| $f_0(1710) \pi^+, f_0 \rightarrow K^+ K^-$                   | ( 6.7 ± 2.9 ) × 10 <sup>-4</sup>     | 198<br>DESIG=88                      |                                       |
| $K^+ \bar{K}_0^*(1430)^0, \bar{K}_0^* \rightarrow K^- \pi^+$ | ( 1.9 ± 0.4 ) × 10 <sup>-3</sup>     | 218<br>DESIG=80                      |                                       |
| $K^0 \bar{K}^0 \pi^+$  | —                                    | 802<br>DESIG=46;OUR EVAL             |                                       |
| $K^*(892)^+ \bar{K}^0$                                       | [e] ( 5.4 ± 1.2 ) %                  | 683<br>DESIG=24                      |                                       |
| $K^+ K^- \pi^+ \pi^0$  | ( 5.6 ± 0.5 ) %                      | 748<br>DESIG=41                      |                                       |
| $\phi \rho^+$  | [e] ( 8.4 ± 1.9 ) %                  | 401<br>DESIG=5                       |                                       |

|  |  |     |                                |
|--|--|-----|--------------------------------|
| $K_S^0 K^- 2\pi^+$                                   | ( 1.64 ± 0.12 ) %                      | 744 | DESIG=26                       |
| $K^*(892)^+ \bar{K}^*(892)^0$                        | [e] ( 7.2 ± 2.6 ) %                    | 417 | DESIG=27                       |
| $K^+ K_S^0 \pi^+ \pi^-$                              | ( 9.6 ± 1.3 ) × 10 <sup>-3</sup>       | 744 | DESIG=43                       |
| $K^+ K^- 2\pi^+ \pi^-$                               | ( 8.8 ± 1.6 ) × 10 <sup>-3</sup>       | 673 | DESIG=42                       |
| $\phi 2\pi^+ \pi^-$                                  | [e] ( 1.21 ± 0.16 ) %                  | 640 | DESIG=8                        |
| $K^+ K^- \rho^0 \pi^+ \text{non-}\phi$               | < 2.6 × 10 <sup>-4</sup> CL=90%        | 249 | DESIG=104                      |
| $\phi \rho^0 \pi^+, \phi \rightarrow K^+ K^-$        | ( 6.6 ± 1.3 ) × 10 <sup>-3</sup>       | 181 | DESIG=105                      |
| $\phi a_1(1260)^+, \phi \rightarrow$                 | ( 7.5 ± 1.3 ) × 10 <sup>-3</sup>       | †   | DESIG=106                      |
| $K^+ K^-, a_1^+ \rightarrow \rho^0 \pi^+$            |  |     |                                |
| $K^+ K^- 2\pi^+ \pi^- \text{nonresonant}$            | ( 9 ± 7 ) × 10 <sup>-4</sup>           | 673 | DESIG=107                      |
| $2K_S^0 2\pi^+ \pi^-$                                | ( 8.3 ± 3.5 ) × 10 <sup>-4</sup>       | 669 | DESIG=112                      |
| <b>Hadronic modes without <math>K</math>'s</b>       |  |     |                                |
| $\pi^+ \pi^0$  | < 3.4 × 10 <sup>-4</sup> CL=90%        | 975 | NODE=S034;CLUMP=B<br>DESIG=119 |
| $2\pi^+ \pi^-$                                       | ( 1.10 ± 0.06 ) %                      | 959 | DESIG=15                       |
| $\rho^0 \pi^+$                                       | ( 2.0 ± 1.2 ) × 10 <sup>-4</sup>       | 825 | DESIG=10                       |
| $\pi^+(\pi^+ \pi^-)_{S-\text{wave}}$                 | [i] ( 9.2 ± 0.6 ) × 10 <sup>-3</sup>   | 959 | DESIG=113                      |
| $f_2(1270)\pi^+, f_2 \rightarrow \pi^+ \pi^-$        | ( 1.11 ± 0.20 ) × 10 <sup>-3</sup>     | 559 | DESIG=90                       |
| $\rho(1450)^0 \pi^+, \rho^0 \rightarrow \pi^+ \pi^-$ | ( 3.0 ± 2.0 ) × 10 <sup>-4</sup>       | 421 | DESIG=103                      |
| $\pi^+ 2\pi^0$                                       | ( 6.5 ± 1.3 ) × 10 <sup>-3</sup>       | 961 | DESIG=149                      |
| $2\pi^+ \pi^- \pi^0$                                 | —                                      | 935 | DESIG=18;OUR EVAL              |
| $\eta \pi^+$   | [e] ( 1.83 ± 0.15 ) %                  | 902 | DESIG=1                        |
| $\omega \pi^+$                                       | [e] ( 2.5 ± 0.7 ) × 10 <sup>-3</sup>   | 822 | DESIG=19                       |
| $3\pi^+ 2\pi^-$                                      | ( 8.0 ± 0.9 ) × 10 <sup>-3</sup>       | 899 | DESIG=17                       |
| $2\pi^+ \pi^- 2\pi^0$                                | —                                      | 902 | DESIG=57;OUR EVAL              |
| $\eta \rho^+$  | [e] ( 8.9 ± 0.8 ) %                    | 724 | DESIG=58                       |
| $\eta \pi^+ \pi^0 3\text{-body}$                     | [e] < 5 % CL=90%                       | 886 | DESIG=64                       |
| $\omega \pi^+ \pi^0$                                 | [e] ( 2.8 ± 0.7 ) %                    | 802 | DESIG=126                      |
| $3\pi^+ 2\pi^- \pi^0$                                | ( 4.9 ± 3.2 ) %                        | 856 | DESIG=59                       |
| $\omega 2\pi^+ \pi^-$                                | [e] ( 1.6 ± 0.5 ) %                    | 766 | DESIG=127                      |
| $\eta'(958)\pi^+$                                    | [d,e] ( 3.94 ± 0.33 ) %                | 743 | DESIG=13                       |
| $3\pi^+ 2\pi^- 2\pi^0$                               | —                                      | 803 | DESIG=61;OUR EVAL              |
| $\omega \eta \pi^+$                                  | [e] < 2.13 % CL=90%                    | 654 | DESIG=128                      |
| $\eta'(958)\rho^+$                                   | [d,e] ( 12.5 ± 2.2 ) %                 | 465 | DESIG=62                       |
| $\eta'(958)\pi^+ \pi^0 3\text{-body}$                | [e] < 1.8 % CL=90%                     | 720 | DESIG=65                       |
| <b>Modes with one or three <math>K</math>'s</b>      |  |     |                                |
| $K^+ \pi^0$  | ( 6.2 ± 2.1 ) × 10 <sup>-4</sup>       | 917 | NODE=S034;CLUMP=K<br>DESIG=120 |
| $K_S^0 \pi^+$  | ( 1.21 ± 0.08 ) × 10 <sup>-3</sup>     | 916 | DESIG=23                       |
| $K^+ \eta$   | [e] ( 1.75 ± 0.35 ) × 10 <sup>-3</sup> | 835 | DESIG=121                      |
| $K^+ \omega$   | [e] < 2.4 × 10 <sup>-3</sup> CL=90%    | 741 | DESIG=129                      |
| $K^+ \eta'(958)$                                     | [e] ( 1.8 ± 0.6 ) × 10 <sup>-3</sup>   | 646 | DESIG=122                      |
| $K^+ \pi^+ \pi^-$                                    | ( 6.9 ± 0.5 ) × 10 <sup>-3</sup>       | 900 | DESIG=45                       |
| $K^+ \rho^0$   | ( 2.7 ± 0.5 ) × 10 <sup>-3</sup>       | 745 | DESIG=82                       |
| $K^+ \rho(1450)^0, \rho^0 \rightarrow \pi^+ \pi^-$   | ( 7.3 ± 2.6 ) × 10 <sup>-4</sup>       | —   | DESIG=108                      |
| $K^*(892)^0 \pi^+, K^{*0} \rightarrow$               | ( 1.50 ± 0.26 ) × 10 <sup>-3</sup>     | 775 | DESIG=83                       |
| $K^+ \pi^-$  |  |     |                                |
| $K^*(1410)^0 \pi^+, K^{*0} \rightarrow$              | ( 1.30 ± 0.31 ) × 10 <sup>-3</sup>     | —   | DESIG=109                      |
| $K^+ \pi^-$  |  |     |                                |
| $K^*(1430)^0 \pi^+, K^{*0} \rightarrow$              | ( 5 ± 4 ) × 10 <sup>-4</sup>           | —   | DESIG=110                      |
| $K^+ \pi^-$  |  |     |                                |
| $K^+ \pi^+ \pi^- \text{nonresonant}$                 | ( 1.1 ± 0.4 ) × 10 <sup>-3</sup>       | 900 | DESIG=111                      |
| $K^0 \pi^+ \pi^0$                                    | ( 1.00 ± 0.18 ) %                      | 900 | DESIG=150                      |
| $K_S^0 2\pi^+ \pi^-$                                 | ( 2.9 ± 1.1 ) × 10 <sup>-3</sup>       | 870 | DESIG=123                      |
| $K^+ \omega \pi^0$                                   | [e] < 8.2 × 10 <sup>-3</sup> CL=90%    | 684 | DESIG=130                      |
| $K^+ \omega \pi^+ \pi^-$                             | [e] < 5.4 × 10 <sup>-3</sup> CL=90%    | 603 | DESIG=131                      |
| $K^+ \omega \eta$                                    | [e] < 7.9 × 10 <sup>-3</sup> CL=90%    | 367 | DESIG=132                      |
| $2K^+ K^-$   | ( 2.20 ± 0.23 ) × 10 <sup>-4</sup>     | 628 | DESIG=67                       |
| $\phi K^+, \phi \rightarrow K^+ K^-$                 | ( 9.0 ± 2.1 ) × 10 <sup>-5</sup>       | —   | DESIG=154                      |

| <b>Doubly Cabibbo-suppressed modes</b>   |           |                                  |        |     | NODE=S034;CLUMP=F |
|--|-----------|----------------------------------|--------|-----|-------------------|
| $2K^+\pi^-$  |           | $(1.28 \pm 0.14) \times 10^{-4}$ |        | 805 | DESIG=116         |
| $K^+ K^*(892)^0, K^{*0} \rightarrow K^+\pi^-$  |           | $(6.0 \pm 3.5) \times 10^{-5}$   |        | -   | DESIG=155         |
| <b>Baryon-antibaryon mode</b>  |           |                                  |        |     | NODE=S034;CLUMP=G |
| $p\bar{n}$   |           | $(1.3 \pm 0.4) \times 10^{-3}$   |        | 295 | DESIG=124         |
| <b><math>\Delta C = 1</math> weak neutral current (<i>C1</i>) modes,<br/>Lepton family number (<i>LF</i>), or<br/>Lepton number (<i>L</i>) violating modes</b> |           |                                  |        |     | NODE=S034;CLUMP=E |
| $\pi^+ e^+ e^-$  | [j]       | $< 1.3 \times 10^{-5}$           | CL=90% | 979 | DESIG=93          |
| $\pi^+ \phi, \phi \rightarrow e^+ e^-$   | [k]       | $(6 +8 -4) \times 10^{-6}$       |        | -   | DESIG=152         |
| $\pi^+ \mu^+ \mu^-$  | [j]       | $< 2.6 \times 10^{-5}$           | CL=90% | 968 | DESIG=73          |
| $K^+ e^+ e^-$  | <i>C1</i> | $< 3.7 \times 10^{-6}$           | CL=90% | 922 | DESIG=94          |
| $K^+ \mu^+ \mu^-$  | <i>C1</i> | $< 2.1 \times 10^{-5}$           | CL=90% | 909 | DESIG=74          |
| $K^*(892)^+ \mu^+ \mu^-$   | <i>C1</i> | $< 1.4 \times 10^{-3}$           | CL=90% | 765 | DESIG=75          |
| $\pi^+ e^+ \mu^-$  | <i>LF</i> | $< 1.2 \times 10^{-5}$           | CL=90% | 976 | DESIG=156         |
| $\pi^+ e^- \mu^+$  | <i>LF</i> | $< 2.0 \times 10^{-5}$           | CL=90% | 976 | DESIG=157         |
| $K^+ e^+ \mu^-$  | <i>LF</i> | $< 1.4 \times 10^{-5}$           | CL=90% | 919 | DESIG=158         |
| $K^+ e^- \mu^+$  | <i>LF</i> | $< 9.7 \times 10^{-6}$           | CL=90% | 919 | DESIG=159         |
| $\pi^- 2e^+$   | <i>L</i>  | $< 4.1 \times 10^{-6}$           | CL=90% | 979 | DESIG=97          |
| $\pi^- 2\mu^+$   | <i>L</i>  | $< 1.4 \times 10^{-5}$           | CL=90% | 968 | DESIG=76          |
| $\pi^- e^+ \mu^+$  | <i>L</i>  | $< 8.4 \times 10^{-6}$           | CL=90% | 976 | DESIG=98          |
| $K^- 2e^+$   | <i>L</i>  | $< 5.2 \times 10^{-6}$           | CL=90% | 922 | DESIG=99          |
| $K^- 2\mu^+$   | <i>L</i>  | $< 1.3 \times 10^{-5}$           | CL=90% | 909 | DESIG=77          |
| $K^- e^+ \mu^+$  | <i>L</i>  | $< 6.1 \times 10^{-6}$           | CL=90% | 919 | DESIG=100         |
| $K^*(892)^- 2\mu^+$  | <i>L</i>  | $< 1.4 \times 10^{-3}$           | CL=90% | 765 | DESIG=78          |

 **$D_s^{*\pm}$**  $I(J^P) = 0(?)$  $J^P$  is natural, width and decay modes consistent with  $1^-$ .Mass  $m = 2112.3 \pm 0.5$  MeV ( $S = 1.1$ ) $m_{D_s^{*\pm}} - m_{D_s^\pm} = 143.8 \pm 0.4$  MeVFull width  $\Gamma < 1.9$  MeV, CL = 90% $D_s^{*-}$  modes are charge conjugates of the modes below.

NODE=S074

| <b><math>D_s^{*+}</math> DECAY MODES</b> | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|--|--------------------------------|-------------|
| $D_s^+ \gamma$                           | $(94.2 \pm 0.7) \%$            | 139         |
| $D_s^+ \pi^0$                            | $(5.8 \pm 0.7) \%$             | 48          |

 **$D_{s0}^*(2317)^\pm$**  $I(J^P) = 0(0^+)$  $J, P$  need confirmation. $J^P$  is natural, low mass consistent with  $0^+$ .Mass  $m = 2317.8 \pm 0.6$  MeV ( $S = 1.1$ ) $m_{D_{s0}^*(2317)^\pm} - m_{D_s^\pm} = 349.3 \pm 0.6$  MeV ( $S = 1.1$ )Full width  $\Gamma < 3.8$  MeV, CL = 95%

NODE=M172

NODE=M172M;DTYPE=M

NODE=M172DM;DTYPE=D

NODE=M172W;DTYPE=G

$D_{s0}^*(2317)^-$  modes are charge conjugates of modes below.

NODE=M172215;NODE=M172

| $D_{s0}^*(2317)^\pm$ DECAY MODES | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|----------------------------------|--------------------------------|-------------|
| $D_s^+ \pi^0$                    | seen                           | 298         |
| $D_s^+ \pi^0 \pi^0$              | not seen                       | 205         |

### $D_{s1}(2460)^\pm$

$$I(J^P) = 0(1^+)$$

Mass  $m = 2459.6 \pm 0.6$  MeV ( $S = 1.1$ )

$m_{D_{s1}(2460)^\pm} - m_{D_s^{*\pm}} = 347.2 \pm 0.7$  MeV ( $S = 1.2$ )

$m_{D_{s1}(2460)^\pm} - m_{D_s^\pm} = 491.1 \pm 0.7$  MeV ( $S = 1.1$ )

Full width  $\Gamma < 3.5$  MeV, CL = 95%

$D_{s1}(2460)^-$  modes are charge conjugates of the modes below.

DESIG=1  
DESIG=7;OUR EVAL; $\rightarrow$  UNCHECKED  $\leftarrow$

NODE=M173  
NODE=M173M;DTYPE=M  
NODE=M173MD;DTYPE=D  
NODE=M173DM;DTYPE=D  
NODE=M173W;DTYPE=G  
NODE=M173215;NODE=M173

| $D_{s1}(2460)^+$ DECAY MODES | Fraction ( $\Gamma_i/\Gamma$ ) | Scale factor/<br>Confidence level | $p$<br>(MeV/c) |
|------------------------------|--------------------------------|-----------------------------------|----------------|
| $D_s^{*+} \pi^0$             | (48 $\pm$ 11) %                |                                   | 297            |
| $D_s^+ \gamma$               | (18 $\pm$ 4) %                 |                                   | 442            |
| $D_s^+ \pi^+ \pi^-$          | ( 4.3 $\pm$ 1.3) %             | S=1.1                             | 363            |
| $D_s^{*+} \gamma$            | < 8 %                          | CL=90%                            | 323            |
| $D_{s0}^*(2317)^+ \gamma$    | ( 3.7 $\pm$ 5.0) %             |                                   | 138            |

### $D_{s1}(2536)^\pm$

$$I(J^P) = 0(1^+)$$

$J, P$  need confirmation.

Mass  $m = 2535.12 \pm 0.13$  MeV

Full width  $\Gamma = 0.92 \pm 0.05$  MeV

$D_{s1}(2536)^-$  modes are charge conjugates of the modes below.

NODE=M121  
NODE=M121M;DTYPE=M  
NODE=M121W;DTYPE=G  
NODE=M121215;NODE=M121

| $D_{s1}(2536)^+$ DECAY MODES | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|------------------------------|--------------------------------|-------------|
| $D^*(2010)^+ K^0$            | seen                           | 149         |
| $D^*(2007)^0 K^+$            | seen                           | 167         |
| $D^+ K^0$                    | not seen                       | 381         |
| $D^0 K^+$                    | not seen                       | 391         |
| $D_s^{*+} \gamma$            | possibly seen                  | 388         |
| $D_s^+ \pi^+ \pi^-$          | seen                           | 437         |

### $D_{s2}^*(2573)^\pm$

$$I(J^P) = 0(?^?)$$

$J^P$  is natural, width and decay modes consistent with  $2^+$ .

Mass  $m = 2571.9 \pm 0.8$  MeV

Full width  $\Gamma = 17 \pm 4$  MeV ( $S = 1.3$ )

$D_{s2}^*(2573)^-$  modes are charge conjugates of the modes below.

DESIG=1;OUR EST; $\rightarrow$  UNCHECKED  $\leftarrow$   
DESIG=4;OUR EST; $\rightarrow$  UNCHECKED  $\leftarrow$   
DESIG=2;OUR EST; $\rightarrow$  UNCHECKED  $\leftarrow$   
DESIG=5;OUR EST; $\rightarrow$  UNCHECKED  $\leftarrow$   
DESIG=3  
DESIG=6

NODE=M148

NODE=M148M;DTYPE=M  
NODE=M148W;DTYPE=G  
NODE=M148215;NODE=M148

| $D_{s2}^*(2573)^+$ DECAY MODES | Fraction ( $\Gamma_i/\Gamma$ ) | $p$ (MeV/c) |
|--------------------------------|--------------------------------|-------------|
| $D^0 K^+$                      | seen                           | 434         |
| $D^*(2007)^0 K^+$              | not seen                       | 243         |

### $D_{s1}^*(2700)^\pm$

$$I(J^P) = 0(1^-)$$

Mass  $m = 2709 \pm 4$  MeV

Full width  $\Gamma = 117 \pm 13$  MeV

DESIG=1  
DESIG=2;OUR EVAL; $\rightarrow$  UNCHECKED  $\leftarrow$

NODE=M182  
NODE=M182M;DTYPE=M  
NODE=M182W;DTYPE=G

## NOTES

- [a] See the Particle Listings for the (complicated) definition of this quantity.
- [b] This is the purely  $e^+$  semileptonic branching fraction: the  $e^+$  fraction from  $\tau^+$  decays has been subtracted off. The sum of our (non- $\tau$ )  $e^+$  exclusive fractions — an  $e^+ \nu_e$  with an  $\eta$ ,  $\eta'$ ,  $\phi$ ,  $K^0$ ,  $K^{*0}$ , or  $f_0(980)$  — is  $7.0 \pm 0.4\%$ .
- [c] This fraction includes  $\eta$  from  $\eta'$  decays.
- [d] Two times (to include  $\mu$  decays) the  $\eta' e^+ \nu_e$  branching fraction, plus the  $\eta' \pi^+$ ,  $\eta' \rho^+$ , and  $\eta' K^+$  fractions, is  $(18.6 \pm 2.3)\%$ , which considerably exceeds the inclusive  $\eta'$  fraction of  $(11.7 \pm 1.8)\%$ . Our best guess is that the  $\eta' \rho^+$  fraction,  $(12.5 \pm 2.2)\%$ , is too large.
- [e] This branching fraction includes all the decay modes of the final-state resonance.
- [f] A test for  $u\bar{u}$  or  $d\bar{d}$  content in the  $D_s^+$ . Neither Cabibbo-favored nor Cabibbo-suppressed decays can contribute, and  $\omega-\phi$  mixing is an unlikely explanation for any fraction above about  $2 \times 10^{-4}$ .
- [g] The branching fraction for this mode may differ from the sum of the submodes that contribute to it, due to interference effects. See the relevant papers in the Particle Listings.
- [h] We decouple the  $D_s^+ \rightarrow \phi \pi^+$  branching fraction obtained from mass projections (and used to get some of the other branching fractions) from the  $D_s^+ \rightarrow \phi \pi^+$ ,  $\phi \rightarrow K^+ K^-$  branching fraction obtained from the Dalitz-plot analysis of  $D_s^+ \rightarrow K^+ K^- \pi^+$ . That is, the ratio of these two branching fractions is not exactly the  $\phi \rightarrow K^+ K^-$  branching fraction 0.491.
- [i] This is the average of a model-independent and a  $K$ -matrix parametrization of the  $\pi^+ \pi^-$   $S$ -wave and is a sum over several  $f_0$  mesons.
- [j] This mode is not a useful test for a  $\Delta C=1$  weak neutral current because both quarks must change flavor in this decay.
- [k] This is *not* a test for the  $\Delta C=1$  weak neutral current, but leads to the  $\pi^+ \ell^+ \ell^-$  final state.

LINKAGE=DEF

LINKAGE=SLE

LINKAGE=EFR

LINKAGE=INC

LINKAGE=DFR

LINKAGE=MAR

LINKAGE=SDQ

LINKAGE=DBF

LINKAGE=KMP

LINKAGE=FIX

LINKAGE=NTC